CYLINDRICITY OF WORKPIECE IN CONVENTIONAL LATHE MACHINE

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We certify that the project entitled "Cylindricity of Workpiece in Conventional Lathe Machine" is written by Nazihah binti Shaharudin. We have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. We herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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I hereby declare that I have read this report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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STUDENT'S DECLARATION

I declare that this thesis entitled *"Cylindricity of Workpiece in Conventional Lathe Machine"* is the result of my own research except as cited in the references. The thesis has not been accepted for my degree and is not concurrently candidature of any other degree.

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To my Beloved Father and Mother

SHAHARUDIN BIN HASAN
NURULAIN BT ABDULLAH BAYANUDDIN

To my siblings

SUHAIL BIN SHAHARUDIN
SULHI BIN SHAHARUDIN
SYAHMI BIN SHAHARUDIN
NURUL ALIAH BT SHAHARUDIN

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ABSTRACT

Cylindrical aspects are one of the most fundamental traits in mechanical designs because they contribute significantly to various mechanical products such as shafts and revolving devices. Besides, it is crucial because it can determine the performance of the parts like the application used in transmission system. Basically, cylindricity can be defined as a condition of a surface of revolution in which all points on the surface are equidistant from a common axis. Cylindrical parts can be produced by using many machines and processes that are available. Numerous factors in manufacturing processes may cause a cylindrical part to depart from its ideal shape. It is essential to design proper experiment for assessing cylindricity. Therefore, the choice of the best combination parameters is important to control the cylindrical geometry. Turning operation using conventional lathe machine is used to produce this feature, while for evaluating the geometry, dial gauge is utilized. From the experiment, the best combination of parameter are feed rate of 0.15 mm/rev which had the biggest effect on cylindricity measurement followed by the cutting speed of 150 m/min and lastly is the depth of cut of 0.5 mm.

ABSTRAK

Aspek kesilinderan adalah salah satu dari aspek asas dalam reka bentuk mekanikal kerana ia menyumbang kepada berbagai-bagai jenis produk mekanikal seperti *shaft* dan alat yang berputar. Selain itu, ia adalah penting untuk menentukan keupayaan sesuatu produk untuk berfungsi seperti yang terdapat pada sistem enjin. Secara umumnya, kesilinderan boleh diterjemahkan sebagai suatu keadaan dimana kesemua titik yang terletak di permukaan silinder berada dalam kedudukan yang sama jarak dari satu paksi yang sama. Komponen yang berbentuk silinder boleh dihasilkan dengan menggunakan pelbagai jenis mesin dan proses yang sedia ada. Terdapat banyak faktor dalam proses pembuatan yang boleh menyebabkan kepada sesuatu komponen yg berbentuk silinder lari dari bentuk yang ideal. Maka, adalah penting untuk merancang eksperimen yang sesuai untuk menilai kesilinderan sesuatu komponen. Oleh yang demikian, pemilihan kombinasi parameter yang terbaik adalah mustahak untuk mengawal geometri silinder. Proses larik menggunakan mesin larik biasa boleh digunakan untuk menghasilkan bentuk tersebut, manakala tolok dial pula dapat digunakan untuk menilai geometri silinder. Daripada eksperimen yang telah dijalankan, gabungan parameter yang terbaik adalah kadar potongan 0.15 mm/ rev yang memberi kesan terbesar kepada ukuran silinder, diikuti dengan halaju potongan 150 m/min dan terakhir adalah kedalaman sesuatu potongan 0.5 mm.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF SYMBOLS

f	Feed Rate, mm/rev
d	Depth of Cut, mm
V	Cutting Speed, m/min
L	Length, mm
D_0	Initial diameter, mm
n	Spindle speed, rev/min

LIST OF ABBREVIATIONS

AISI	American Iron & Steel Institute
CMM	Coordinate Measuring Machine
CNC	Computer Numerical Control
FKM	Fakulti Kejuruteraan Mekanikal
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Cylindrical features are one of the most basic features in mechanical designs because they contribute significantly to various mechanical products. Generally, cylindricity is a three dimensional tolerance that controls how much a feature can deviate from a perfect cylinder. But, basically, cylindricity is defined as a condition of a surface of revolution in which all points of the surface are equidistant from a common axis. There are many misconceptions surround cylindricity. This is because cylindricity is very difficult to characterize in the presence of unrelated signals in any data such as shape distortions produced by tilt and eccentricity mask the expected shape of the workpiece, since the knowledge of the measurement of cylindricity profiles is relatively limited.

Products with cylindrical surfaces are manufactured in many industries and useful in many applications. For examples, in paper, chemical, steel, heating or shipping industries require regular estimations of cylindricity profiles during the production process. One of the most often geometrical elements that been produced details are transmission systems, precision gauges and revolving devices. In most cases they represent very responsible part of the machine or been used in automotive sectors and therefore they require very thorough, full accuracy analysis. It is not enough just to measure their diameters or positions, but it is crucial to measure their out-of-roundness as well.

Nowadays, cylindrical parts can be produced by using many machines or process that are available in industries such as lathe machine and Computer Numerical Control machine (CNC) in turning process, as well as cylindrical grinder in grinding process. Cylindricity is found by taking numerous diameter measurements or slices and comparing the highest diameter measurement to the lowest diameter measurement across the entire rod face. The range between the maximum and minimum diameter measurements is the value for cylindricity.

Determining the cylindricity of any part can be quite time consuming when using conventional measuring devices such as dial indicators, Pi Tapes and micrometers. The data collected will probably be inaccurate and misleading due to the limitations of the measurement tools themselves. Advanced electronic measuring system such as Coordinate Measuring Machine (CMM) can produce accurate picture of the exact geometric shape of a cylinder. The pictures can help to diagnose problem and help to ensure that new cylinder will be successful in use.

1.2 PROBLEM STATEMENT

A huge number of mechanical parts embrace of cylindrical features. A vital geometric characteristic that is used to control form and function of cylindrical features is cylindricity. Significant and serious error associated with this characteristic may result in the breakdown or failure or imperfect functioning of the corresponding part. The accuracy of cylindricity measurement can leads to strict tolerancing and consequently, to avoid rejections of valid specimens which are very costly. In material removal process which is in turning operation specifically, cylindrical shaft can be developed using conventional lathe machine by controlling some parameters to get accurate geometry. Cylindricity of workpiece is crucial because it can determine the performance of the part. Besides that, defects such as wear and tear can be prevented and also the lifespan of the part or component attach to it (if any) can last longer.

1.3 PROBLEM OBJECTIVES

i) Investigating the cylindrical effect of different cutting speed, depth of cut and feed rate on the workpiece of medium carbon steel in conventional lathe machine.

ii) Evaluating the geometry of the machined workpiece using dial gauge and analyzing the result to determine the best combination of cutting parameters.

1.4 SCOPE OF STUDY

The scope of the study for this project is to conduct experiments in order to investigate the cylindricity of workpiece. The material used for this investigation is medium carbon steel. The accuracy of cylindricity measurement can be controlled by many parameters like feed rate, cutting speed, depth of cut and type of coolant. In this project, the investigation is based on three parameters; cutting speed, feed rate and depth of cut which are essential in turning process. After the turning operation, the geometry is to be evaluated and analyzed.

1.5 PROJECT BACKGROUND

This project is to investigate the cylindricity of workpiece using medium carbon steel. AISI 1045 is selected as the raw material which is in solid bar shape. The dimensions are: 150mm in length and 40mm in diameter. There are three parameters that have been identified and will be used in this experiment, which are the cutting speed, depth of cut and feed rate. Three different values are specified for each parameter. Taguchi’s approach is used for determining the number of experiment that will be conducted in this project. This type of method is based on the numbers of level design and the number of factor that have been specified. Power saw machine is to be used to cut the raw material into desired dimension. Other than that, conventional lathe machine is to be used for turning process. The cutting tool that will be used in this experiment is carbide insert. Another device that will be used for evaluation of cylindricity is the dial gauge. Lastly, the data that have been collected from the experiment will be analyzed by plotting graphs using Excel.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed the general information of medium carbon steel and its properties, cutting tool, lathe machine, turning process, as well as coordinate measuring machines which are directly incorporated in this project.

2.2 STEEL

Metals and alloys have many useful engineering properties and so have extensive application in engineering designs. Iron and its alloys (principally steel) account for about 90 percent of the world's production of metals mainly because of their combination of good strength, toughness and ductility at a relatively low cost. Each metal has special properties for engineering designs and is used after a comparative cost analysis with other metals and materials. (Smith, 2006)

Steel is an alloy of iron that contains carbon ranging by weight between 0.02% and 2.11%. It often includes other alloying ingredients as well: manganese, chromium, nickel and molybdenum; but it is the carbon content that turns iron into steel. There are hundreds of compositions of steel available commercially. Generally, they can be grouped into four categories which are plain carbon steels, low alloy steels, stainless steels and tool steels. (Groover, 2007)

Only the first category will be discussed here. Plain carbon steels are containing manganese as an alloying enhances strength and hardness that ranges between 0.30 and 0.95 percent. Plain carbon steels have three classes: low carbon steels (less than 0.20% carbon content), medium carbon steels (0.20% to 0.50% carbon content) and high carbon steel (greater than 0.50% carbon content). As the carbon content of the plain carbon steels is increased, the steels become stronger but less ductile. Plain carbon steels have been used in industry for strengthen parts and often used in forgings, gears, and other parts for automotive and structural applications. (Smith, 2006)

2.2.1 Medium Carbon Steel

Groove, 2007 has stated that carbon steel with carbon content ranging 0.20% to 0.50% is termed as medium carbon steel. They are specified for application requiring higher strength than the low carbon steels such as shafts and gears in automotive field also crankshafts and connecting rods in machinery components. Medium carbon steels are often heat treated to obtain higher strength, such as by quenching and then tempering.

Some improvements and developments have been made due to some weaknesses because of low carbon content. Therefore, medium carbon and high carbon steel have more demand in market compare to low carbon steel. It has been known that medium carbon steels are mostly used for simple applications; however, new applications have been developed for which good and better formability is required (Herreraa et al, 2006). Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing.

2.3 CUTTING TOOL

There are many types of tool material, ranging from carbide inserts (Figure 2.1), high-carbon steel to ceramics and diamonds, are used as cutting tools in today's metalworking industry. It is important to be aware that differences do exist among tool materials, what these differences are, and the correct application for each type of material.

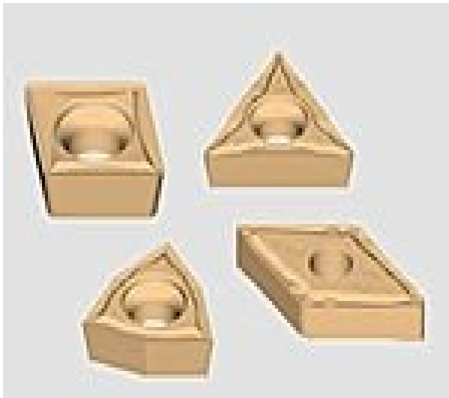

Figure 2.1: Carbide inserts

Source: www.directindustry.com (2009)

The various tool manufacturers assign names and numbers to their products. Many of these names and numbers may appear to be similar, but the applications of these tool materials may be entirely different. In most cases the tool manufacturers will provide tools made of proper material for each given application. In some particular applications, a premium or higher-priced material will be justified.

This does not mean that the most expensive tool always the best tool. Cutting-tool users cannot afford to ignore the constant changes and advancements that are being made in the field of tool material technology. When a tool change is needed or anticipated, a performance comparison should be made before selecting the tool for the job. The optimum tool is not necessary the least expensive or the most expensive, and it are not always the same as the tool that was used for the job last time. The best tool is the one that has been carefully chosen to get the job done quickly, efficiently and economically.

A cutting tool must have the following characteristics in order to produce good quality and economical parts:

a) Hardness: hardness and strength of the cutting tool must be maintained at elevated temperature,

b) Toughness: toughness of the cutting tools is needed so that tools do not chip or fracture, especially during interrupted cutting operations,

c) Wear resistance: wear resistance means the attainment of acceptable tool life before tools need to be replaced.

The materials from which the cutting tools are made are all characteristically hard and strong. A wide range of tool materials are available for machining operations. (Nelson, 2001)

2.3.1 Cemented-Carbide Toolbits

According to Krar et al, 2005, cemented-carbide toolbits are capable of cutting speeds three to four times those of high-speed steel toolbits. They have low toughness but high hardness and excellent red-hardness qualities (red hardness is the ability to maintain a sharp cutting edge even when it turn red because of the high heat produced during the cutting operation).

Cemented carbide consists of tungsten carbide sintered in a cobalt matrix. Sometimes, other materials such as titanium or tantalum may be added before sintering to give the material the desired properties. Straight tungsten carbide toolbits are used to machine cast iron and nonferrous materials. Since they crater easily and wear rapidly, they are not suitable for machining steel. Crater-resistant carbides, which are used for machining steel, are made by adding titanium and/or tantalum carbides to the tungsten carbide and cobalt. Different grades of carbides are manufactured for different work requirements. Those used for heavy roughing cuts contain more cobalt than those used for finishing cuts, which are more brittle and have greater wear resistance at higher finishing speeds.

2.4 LATHE MACHINE

A lathe is a machine tool which spins a block of material to perform various operation such as facing, taper turning, treading, chamfering drilling, boring, knurling of deformation with tools that are applied to the workpiece to create an object which has symmetry about an axis of rotation. Lathes are manufactured in a wide range of sizes. The average metric lathe used in school shops may have a 230 to 330 mm swing and have a bed length of from 500 to 3000 mm.

The main parts of the lathe machine as shown in Figure 2.2 are bed, headstock, quick-change gearbox, carriage and tailstock. Besides that, many lathe accessories are available to increase the versatility of the lathe and the variety of work that can be machined such as lathe centers, chucks, collets, mandrel, and lathe dogs. Overall, lathe is the most commonly used machine in the industry because it can be used for many types of operations. Modern lathe machines have come with other types such as the engine, turret, single and multiple-spindle automatic, tracer and now computer-numerical-controlled. (Krar et al, 2005)